The Sidereal Messenger.

CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory.

MAY, 1885.

CONTENTS:

"He telleth the number of the stars; He calleth them all by their names."

ARTICLES:— Page

The Instruments and Work of Astronomy. Professor ASAPH HALL..... 97
The Star of Bethlehem. THE EDITOR..... 110
Recently Discovered Asteroids. Professor DANIEL KIRKWOOD..... 114
The School of Practical Astronomy at Willet's Point, N. Y. Harbor. Professor E. S. HOLDEN..... 116
The Red Spot on Jupiter. Professor C. A. YOUNG..... 119

EDITORIAL NOTES:—

Meeting of the American Association for the Advancement of Science. Observations of the Solar Eclipse of March 16th, at Princeton, by Professor YOUNG and Assistant MCNEILL. Notes on the Observation of the Sun as seen at Hillsdale College, March 16, 1885, Professor A. E. HAYNES. Note on the Address of Professor Hall Observations of the First Contact of the Partial Solar Eclipse of March 15—16, 1885, made at the U. S. Naval Observatory, Washington.—Astronomical Notes from E. E. BARNARD.—Jupiter's Satellite IV.— "Gegenschien."—Aurora Borealis.—Nebulæ, New and Old.—New Nebula.—Note on G. C. 1409.—A Legal Standard of Time for Wisconsin. E. S. H. Observations of the Solar Eclipse of March 16, 1885, at South Hadley, Mass., by Misses E. M. BARDWELL and I. G. MACK. List of Subscribers.....120—127

BOOK NOTICES:—

Elements of Analytical Geometry, by SIMON NEWCOMB, HENRY HOLT & Co., Publishers. LE CONTES' Compend of Geology. D. APPLETON & Co, Publishers.....127—128

ADVERTISEMENTS.....Cover Pages

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CONDUCTED BY WM. W. PAYNE,

Director of Carleton College Observatory, Northfield, Minnesota.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 4. NO. 4. MAY, 1885. WHOLE NO. 34.

THE INSTRUMENTS AND WORK OF ASTRONOMY.*

PROFESSOR ASAPH HALL.

The progress of Astronomy has given us such a knowledge of the earth and of its relative position in space that we can now form a good idea of the conditions in which the astronomer is placed, and of the problems that are presented for his study. We know that our earth, which was formerly thought to be the centre of the universe, is only a secondary body, and is so small that it would require many thousand such bodies to form our central sun. It is from this small body, of an irregular figure, which revolves around the sun, and at the same time rotates rapidly on one of its axes, that the astronomer must study the motions of the other planets, determine his distance from the central sun, and discover the laws that preserve the order and harmony of our solar system. Beyond the planets lies the sidereal system of innumerable stars, which at first must perplex the observer by their number and variety, but which finally become his landmarks and guides. Our earth,

"That spinning sleeps
On her soft axle, while she paces even,
And bears thee soft with the smooth air along."

*An address delivered at the opening of the Leander McCormick Observatory of the University of Virginia, April 13, 1885.

by her motions furnishes us the means of measuring time and space, and enables us to lay our work on sure foundations.

At the beginning of his labor the astronomer had none but the simplest tools, and had to trust wholly to observations with the naked eye, These would be so crude that a long time must elapse before much progress could be made in explaining the complicated motions of the sun, the moon, and the planets. But men so situated are called on to exercise thought and keen judgment, to invent and test theories, and to search carefully for the truth; and these are perhaps the best circumstances under which life can be spent. Hence, although the observations of the ancient astronomers are now of little value, one is tempted to envy them their opportunities, since it is not so much the truth itself, as the struggle for it, that strengthens and ennobles the character. It must have cost many years of patient labor and much ingenuity to obtain the results given by HIPPARCHUS two thousand years ago. The periods of the five planets visible to the naked eye determined by this great astronomer are wonderfully near the truth, and his explanation of the motions of the sun and moon, and his discovery of the precession of the eqinoxes show that he had employed his instruments well, and had arrived at many correct ideas concerning the motions of the heavenly bodies. In fact we may well believe that some of those old astronomers, aided by their primitive instruments, had formed true views of the theory of our solar systsm; but if so, such views were overwhelmed by more popular notions, and were set aside until the time of COPERNICUS.

To accomplish the work of the ancient astronomers many ingenious instruments were invented, most of which have been laid aside and are now nearly forgotten. But means of measuring angles and time were devised which, though rude, enabled the astronomer to begin the foundation of this science. The Greeks were skilled in geometry, and the use of the circle for the measurement of angles must be very old. This method is so simple that its defects would be mechanical rather than theoretical. On the other hand, the ancient instruments for measuring the important element of time were the dial and those

that depend on the flow of water or of sand; and, notwithstanding the ingenuity displayed in their construction, even the best of them must have been very unsatisfactory. In striking contrast with these the modern instrument for the measurement of time is remarkable for its simplicity and effectiveness. We owe the invention of the pendulum to GALILEO, and there can hardly be found in the history of science a better illustration of the value of a good theory than in the application of this simple and excellent instrument to measure intervals of time. The pendulum was soon applied by HUYGENS to the control of clocks, and through his labors and those of EULER its theory was made nearly perfect. It needs only a comparison of the theory of the pendulum with those of the ancient instruments to show the value of GALILEO's invention, by means of which we have obtained not only an astronomical instrument of the first importance, but also a valuable instrument of geology.

From the evidence that has come down to us by means of coins and other relics of former times it seems probable that the ancients had a knowledge of lenses, and used them in some of the arts; but they do not appear to have applied them to astronomical instruments. A long interval, nearly fifteen centuries passed away after the epoch of PTOLEMY before this important step was taken, and before any radical improvement was made in the art of making astronomical observations. The results of the old methods of observing are shown at their best in the work of TYCHO BRAHE, whose wealth and skill procured the best instruments of his time, and whose industry accumulated a great mass of observations of nearly all the celestial objects visible to the naked eye. It is well known that these observations were of great value, since, in the hands of KEPLER, they led to the discovery of his famous laws of the motions of the planets around the sun. But for another reason these observations mark one of the most important epochs in the progress of the science. This was the application of the telescope to astronomical observations. The results obtained by TYCHO BRAHE were of the highest excellence of their kind, and some skillful observers refused to use the instrument that GALILEO had applied to astronomy. But the power gained was so

great, and the wonders disclosed were so interesting that rapid progress was made. The telescope was first used naturally and simply in the line of discovery. The satellites of *Jupiter*, the spots on the sun, the phases of the planets predicted by COPERNICUS and the ring of *Saturn* were soon discovered. This marvelous instrument extended our knowledge also to the wonderful stellar systems and nebulæ that are scattered through the celestial spaces and explored regions forever closed to the naked eye. The changes produced in the thoughts and feelings of men by this sudden progress in astronomy were great. Cherished theories were brought into disrepute, and excitement and discussion followed during one or two generations. This enlargement of knowledge and the quickening of thought and investigation that followed form a remarkable epoch in the history of our civilization.

This great advance in descriptive astronomy was soon followed by attempts to improve the methods of measuring angles. The micrometer and microscope were invented, but more than a century elapsed before the real value of this application of the lens was recognized. The old method of measurment by means of sights with the naked eye had been employed by TYCHO BRAHE, and his observations were made so famous by the work of KEPLER that the need of more accurate measurements was not felt. To one who looks back on such a state of things, and who sees the slow and uncertain actions of men, and how improvements are delayed and set aside for trifling reasons, a feeling of impatience is apt to come. Generally an actual need is required to spur us forward. During a great part of the seventeenth and eighteenth centuries practical astronomy had outstripped theory, and waited patient and satisfied. But the discovery of NEWTON and the labors of his great followers in France and Germany changed this condition. The need of more accurate observations was felt as soon as theoretical astronomy had become extended and refined, and then the full application of the telescope was soon brought about. So completely was this done that in the division of the circle and the measurement of angles hardly any improvement has been made during the last fifty years. During this time observations are

nearly comparable in accuracy, and their value depends as much on the astronomer as on his instruments. By this application of the telescope the gain is so great that the ancient observations are now of little value. They served to lay the foundations of the science and were useful in their day; but the refined observations now extend over such an interval of time, and they furnish such accurate data that the astronomer has but little need to refer to the rude work of former times. It is worth while to notice that at the present time the relative positions of practical and theoretical astronomy are nearly the same as they were two centuries ago — that is, theoretical astronomy has fallen behind observation.

Since the invention of the telescope it has received one remarkable improvement which has very much increased its usefulness. The astronomers who first used the telescope employed single lenses of several hundred feet focal length, which made the use of the instrument extremely inconvenient, since it was difficult to give it a steady mounting and to protect it from the wind and weather. The difficulty was overcome by the discovery of the achromatic lens. This invention produced our modern telescope, whose form has not been essentially changed in the last hundred years. During the present century the improvements have been chiefly in the refinement and enlargement of instruments. While the art of dividing circles and of making screws has not perhaps been much advanced in recent years yet many ingenious devices have been made which assist the astronomer, and which tend to increase the accuracy of his measurements. Still it is difficult to believe that any great improvement in the art of observing is to be made by such means. Some more radical change is necessary, and for this we may look hopefully to the present rapid growth in the knowledge of the physical sciences. But should this never come, the astronomer can rely on the other fundamental element, that of time, by the lapse of which his work obtains a sure increase of value.

When the achromatic lens was discovered the knowledge of the manufacture of optical glass was so limited that this lens was at first only a few inches in diameter, and thus the light-

power of the telescope was not great. This condition turned attention again to the construction of reflecting telescopes, some of which were made of very great size. These, in the hands of men who understand their construction and who are able to keep them in good order, have done good service in discovery and in the descriptive parts of astronomy. But the standard work of the science has been done by the refracting telescope. About the beginning of this century the inventions and labors of GUINAND and FRAUNHOFER produced lenses of ten to fifteen inches in diameter, and in recent years their followers have been so successful that now it is not easy to set a limit to the size of the future refracting telescope. The chief difficulty is still, however, in the manufacture of the glass; and here is a field for investigation which invites the ingenuity of our countrymen. Already it is something for our country to be permanently proud of that it is chiefly to American genius and skill that we are indebted for the great progress made in the improvement of the refracting telescope within the last thirty years. There can be no doubt that this increase in definition and light-power will give us a substantial gain in scientific knowledge. Of course new difficulties will arise in the use of very large instruments, and more careful investigations will need to be made of the effects of flexure, temperature and other sources of small errors; but these difficulties will be overcome. With the complete knowledge of its errors the increase of light and magnifying power of the large telescope will give us decided advantages in certain kinds of observation. And here it is interesting to notice the difference in the progress of the theories of the two principal instruments of astronomy — the pendulum and the telescope, both of which have now been brought to a high state of efficiency. The complete theory of the pendulum was given by EULER more than a century ago, although this theory depends on the motion of a rigid body, and the investigation requires a complicated mathematical treatment. On the other hand, the theory of lenses depends on comparatively simple mathematical conceptions, but after passing through the hands of the greatest masters of analysis this theory remained imperfect until about fifty years ago, when

it was finally placed on a rigorous basis.

In the case of the large telescope we must not, however, commit the common error of expecting too much from the use of such an instrument. Measured by the relative amount of light gathered the gain seems great, but when we pass from a fifteen-inch objective to one of thirty inches in diameter our gain in the visibility of stars is only one and a half magnitudes. It is true that the number of stars brought to view by the larger glass in the shell of our great celestial sphere is very great, but they are of the faintest kind, and the study of these stars is very laborious. It can be only in a distant future that such stars will be brought into catalogues, their positions determined, and their peculiarities learned. But even an approximate enumeration of these stars will be of value by giving us some idea of the number of stars in the different magnitudes, and the law of increase of these numbers, as our vision is extended into the depths of space. There are many stars that present variations and peculiarities of light and color that are well worthy of a careful study with the best telescopes. We have also a great number of double-stars, in the measurement of which a good telescope can be employed advantageously. The study of the motions of the double-stars is hardly begun, and considerable time must necessarily elapse before much knowledge can be gained. This is a field of observation where practice and care add greatly to the value of the results.

Again, there is an extensive class of celestial objects well worthy of a careful study with the great telescopes of the present time. These are the nebulæ — the strange, fantastic objects of the siderial world. As distant as the stars, the nebulæ frequently subtend large angles, and must be of enormous extent. Whether they change in light or position is an interesting question, for the solution of which we need, first of all, good observations. Careful drawings of these objects with respect to the stars near them would furnish the means of judging in the future of their changes of position, and photometric observations would determine their changes of light, if such exist. If photography could be applied to give us exact pic-

tures of the nebulæ, it would be a great gain, but probably this cannot be done yet to any extent, and we must trust to hand-drawings, with all their imperfections.

By means of its light-power the great telescope will doubtless be an important agent in the study of the surfaces of the sun, moon, and planets. Although these interesting objects have been observed since the invention of the telescope, they are still worthy of the most careful attention. The changes that take place on these surfaces are very curious and their causes are a mystery. In this kind of work photography is already rendering great assistance, and improvements in this art may be expected. Also in the stellar spectroscopic investigations of the future the great telescope must play an important part. Should this method of determining the motions of the stars be made certain and accurate we may look in this direction for interesting discoveries in stellar astronomy. There is one general consideration, however, that it is not well to overlook. This is the fact that all the obvious and striking discoveries of astronomy have been made long since. This condition follows from the nature of the case and from the progress of the science. The five bright planets of our system were soon discovered with the naked eye, and it needed but the smallest telescopes to reveal some of their satellites. The same telescopes showed also the sun-spots, the composition of the milky way, the clusters of stars, double-stars, and many of the nebulæ. With the improvement of this admirable instrument the field of discovery has been widened greatly, but the objects that remain to be discovered are, of course, faint and difficult to be seen. The future discoveries in astronomy, therefore, are to be looked for rather as the result of careful and perservering research, and are not to be expected simply from an increase of instrumental means. The astronomer should be provided with the best instruments, but, at the same time, he has a just demand for a kind and considerate judgment of his labors. There are many causes of delay and failure, and, even under the most favorable conditions, it may require years of hard work to bring his undertaking to a successful end. Generally we must remember that, as any science approaches a complete state, its further pro-

gress will become slow and difficult. At the present time astronomy needs no poor observations and badly arranged plans, but having become so closely connected with theory, it now needs thoughtful and careful observations and their complete reduction and discussion. The astronomer of to-day may well take his motto from one of our ablest men of science, *Pauca sed matura*. Your new observatory has before it a choice in a wide field of labor; and, from its good position in a fine climate, we feel confident that it will soon take a high rank among its sister institutions.

In considering the changes which the science of astronomy has undergone through the improvement of its instruments we must not forget the changes in the astronomer himself. This would be to overlook the most important factor in the question. During the early days of astronomy a large amount of self-denial and of patience and perseverance must have been required in the astronomer, and doubtless many of the ancient astronomers were men of high character. But this was lost during the middle ages; and for some centuries preceding the revival of science the term "astronomer" was equivalent to "astrologer." KEPLER* himself was for a time a devotee of the black art, and computed horoscopes. Such seems to have been the prevailing idea of an astronomer in the time of SHAKSPEARE. Thus we read:

> **"O learned indeed were that astronomer**
> **That knew the stars, as I his characters,**
> **He'd lay the future open."**

SCHILLER has described in a striking manner the influence of astrology in his picture of the gloomy Wallenstein. By combining in some degree the characters of astronomer and priest the astrologer acquired influence and wealth in the ages of ignorance and superstition. But the great changes wrought in astronomy by KEPLER, and by NEWTON and his followers, put in the background the mythical part of the subject, and gradually compelled the astrologer to become a scientific man. Instead of mysterious predictions of the destiny of man, inferred

* It is an item of history worth preserving that it was by the advice of TYCHO BRAHE, a practical astronomer, that KEPLER abandoned his mystical labors, and undertook to deduce the laws of planetary motion from observed phenomena.

from the stars and planets that culminated at his birth, his work became a study of the motions of the heavenly bodies; and the explanation and prediction of these motions in accordance with the law of gravitation created the science of astronomy.

First, the motions of our solar system and of the comets were shown to be subject to this law of nature, and the telescope has brought to light numberless stellar systems where the same law undoubtedly prevails. A true mechanical theory having been established, this in its turn exerted a wholesome influence on the astronomer. But the change from careless and inaccurate work to correct and exact methods was slowly brought about. If any one wishes to test this statement let him undertake the discussion of some of the observations made in the seventeenth century. Good observations of the objects discovered at that time, such as the satellites of SATURN, would be valuable now for the determination of periodic times and changes in the orbits, but an examination of those observations will show rude and careless methods in fixing positions, and at times something worse. An experience of my own, costly in the time and labor thrown away, has convinced me that the astronomers of those times had the practice of changing, or in technical phrase, of "cooking" observations, to an extent of which the astronomer of to-day gives no example. We find occasionally an astronomer of the present time who will change a little his results, being careful not to alter the mean value, the intention probably being to give an appearance of greater accuracy to his measurements. But even this species of venial dishonesty is not common. This great improvement seems to have been produced by the general advance in the science itself, rather than by any superiority in the morals of the astronomers, who in this respect are of course very much like other men. When, however, observations are so closely connected with theory, and can be subjected to such rigid tests, the observer soon learns the truth of the old saying, that honesty is the best policy, and that tampering with observations is dangerous. Under these conditions, therefore, it is not surprising that astronomical observations have become remarkable for their truthfulness.

It is worth while to notice, in this connection, the importance of a full and orderly record, and also the advantages of a common system of notation. It is a fault with some able observers that their record is carelessly kept, dates being omitted, and the whole matter so disorderly that, after a few days, the observer himself cannot decipher his own writing. In doing a large amount of observing this is a serious fault, and it is one that can be remedied by a little care and patience. The other fault, that of choosing new and uncouth symbols to express common and well-known things, results so much from the personal vanity of able men that it may be beyond control; but, at the same time, this practice introduces into theoretical astronomy much needless confusion. This department of astronomy is now a great field of applied mathematics and rational mechanics, and a common notation would be very useful. At present the symbols are so varied that in complicated investigations, such as the development of the perturbative function, it is almost necessary that each astronomer should repeat the investigation in full, in order to understand the meaning of the symbols.

I have endeavored to give an outline of the past and present condition of astronomy—the oldest and most advanced of the natural sciences. Its theories are now so well established that it lacks the novelty of other sciences, and many of its processes partake of the rigor and dryness of mathematics; yet this science must ever remain an interesting study. As time passes away the observations already accumulated will become more and more valuable. The astronomer of the future will be able to correct the values of his constants, and to increase the accuracy of his predictions. The orbits of the moon, the planets and their satellites, will be more accurately known; and the lapse of time must bring to light also many results of the highest interest, especially in stellar astronomy, which will give a clearer insight into the theory of our science, and which will extend and perfect its domain. The astronomer, therefore, has the satisfaction of feeling that his labors are a contribution to a grand and progressive science, and one that must continue as long as the heavens endure.

The establishment of an astronomical observatory by the old-

est university in our country is an event worthy of consideration in respect to the general question of education. The founder of this university was a man who had a better understanding of the tendencies of his time than any other man on this continent. He knew better than any one else the meaning of our Revolutionary War and the French Revolution. He saw that, no matter how the tide of affairs might ebb and flow from year to year, the great current of events tended always toward one end, and that was the abolition of class privileges and a broadening of the rights of man. He had, moreover, the courage of his convictions, and spoke what he thought. That such a man should stir up bitter opposition is unavoidable. One needs but to turn back the pages of our history to the beginning of this century to find him the object of the fiercest denunciation. In fact, those of us whose memories go back fifty years may have personal recollection of such denunciations from some of the pulpits of our land. Happily, such feelings have mostly passed away, and nearly all of us can now see that even the abolition of a church tax may prove a good thing. We may, therefore, be able to judge more justly the actions of the man who was the bold advocate of truths that were sometimes unpleasant. But if JEFFERSON believed in the fullest liberty of man, and in his exercise of all political rights, he believed also that the most ample and complete means of education should be provided. Naturally, therefore, the crowning work of his life was the founding of a great educational institution—a university in which all branches of learning should be taught. The McCormick astronomical observatory is another step toward the completion of his plans

It is not for me to enter on the vexed question of the relative merits of scientific and classical studies, but it is sufficient to know that in a university both are to be pursued, since it is the purpose of such an institution to apply the various kinds of discipline to promote the development of mind and body. Let me, however, call attention to a characteristic of the study of such a science as astronomy, which is, I think, not often mentioned. The mathematician has for his field of labor the infinity of numbers and of space. He needs no instruments; a pencil

and paper are sufficient, and he would scorn to be limited or controlled by such a vulgar thing as an experiment or an observation. He deals wholly with symbols and lives in an ideal world. In that world parallel lines meet and space has dimensions of every order. The pure mathematician is therefore an idealist of the extremest type. The classical studies give power of expression and grace of utterance; but how rarely do we find a man of the liberal professions who can acknowledge himself to be in the wrong. Generally it is the business of his life to plead a cause and to make out a case. Now the purpose of a science such as astronomy is to discover the truth, and when found to acknowledge it. If an astronomer makes a mistake he feels bound to correct it, and not to hide it. It is in this totally different method of looking at matters, and in the practice of bringing all theories to the test of experiment, and in unsparingly rejecting the false, that the scientific method consists. And it is here, I think, that science is destined to improve our methods of instruction, not so much by the new matter it introduces, as by the different method it teaches. Let us take a single example in the subject of political economy, and one that has agitated our country during the past two generations, that is, the question of a protective tariff. Is this a beneficient regulation, which tends to increase the wealth of the country, or is it a cunning scheme of legalized robbery, by means of which a part of the community is enriched at the expense of the other parts? Here is a question of great importance and one that demands solution at the hands of our public men. It has become so inwoven with our system of industry that it is now a complicated matter and requires judicious treatment. But it can never be settled by orations and the pleas of men who present only a part of the evidence. It is a question that should be studied according to the scientific method. Other examples may be found in what is called history, a study the most interesting, and which should be one of the most instructive. But the books on this subject are so distorted by prejudice, that one is continually reminded of the old fable of the picture of the man and the lion, and he feels that it is necessary to hear the lion's side of the story. Shall we ever outgrow such falseness? I

think so, but it will be done only by a radical change in the methods of investigation.

We rightly look to our colleges and universities for the men who are to form and direct public opinion; and it is from these institutions we expect those who are to survey the paths and guide the way in our social progress. The university therefore has a right to our earnest support. At the present time the boundaries of the natural sciences are rapidly widening, and I hope the founder of your astronomical observatory may find emulators of his generosity who will furnish you with ample means for the culture of all branches of science. Thus may your University continue to act a noble part in the intellectual development of our country.

THE STAR OF BETHLEHEM.

WM. W. PAYNE.

From recent notices in the newspapers public attention has been called to the supposed re-appearance of a certain star, well known to the Bible student, the "Star of the East," or the "Star of Bethlehem" as some writers have termed it. In some of these accounts, the claim that this notable star has re-appeared this year, is apparently so certain, that its place in the heavens has been pointed out, and the time of day given when it could be seen. In one instance it was urged that persons should seek early opportunity to observe this morning star because it was fast receding from sight. Is it any wonder that many people would take advantage of such advice whether certain of its truth or not, if they might possibly look on the face of a star once divinely chosen to mark the time and place of the birth of JESUS CHRIST in sacred history? Though it be probably true, yet to such it will be disappointing to say that the star referred to was undoubtedly the planet *Venus* as she was recently nearing the *Sun* from the west.

Whether the real Star of Bethlehem has been seen at all or

not, since its first memorable appearance it may be profitable to consider briefly the studies of Christian scholars and astronomers in modern time to know something of the evidence on which their views are based.

What was it that the Magi in the East saw according to the account given in the second chapter of Matthew? So far as we know various prominent Biblical scholars in discussing this question have supported one of the following points:

1. It was a miraculous light appearing like a star.
2. A conjunction of the planets *Jupiter* and *Saturn* first, and finally of *Jupiter* and *Mars*.
3. A comet; and
4. A new or temporary star.

In regard to the first point the student of science can have nothing to say as to its truth or falsity, because he knows nothing about it by his methods of study. His opinions are his own and he has a right to them, and if a seeker after truth he will express them with deference and becoming modesty, in view of the opinions of Christian men, which are drawn from premises that may be true, but wholly different in kind.

The other theories would naturally interest astronomers, and they have given attention to them, certainly from the early part of the present century.

In 1826 Professor IDELER, astronomer and linguist at the Berlin University, advanced the idea that the star which the Magi saw was, in fact, a conjunction of the planets *Jupiter* and *Saturn*, which, according to late views, was in the third year before the birth of CHRIST. His imperfect calculations at that time put the two planets about one half degree apart, in nearest approach, a distance equal approximately to the apparent diameter of the *Moon*. To make the two planets appear as one star, when so great a distance apart, IDELER ingeniously supposed that the wise men were near-sighted. In 1831 the distinguished ENCKE repeated the calculations and found that there were three conjunctions of the planets, *Jupiter*, *Saturn* and *Mars* in the

year above named, May 29th, September 3rd and December 5th; but that the distance between the two planets was about one whole degree at each of the three conjunctions, so that the two planets could not have been seen as one unless the Magi were miraculously short-sighted, as wittily suggested by Professor PROCTOR in 1882.

It is easy to see how the conjunctions of these great planets within a few years of the birth of CHRIST, in the astronomical sign of *Pisces* of the Zodiac should gain wide attention. The teachings of astrology interpreted the conjunctions of these planets as foreshadowing great national events, and the sign *Pisces* was known to belong to the Jewish nation, hence a conjunction — not only one but three — in *Pisces* was significant of the birth of CHRIST, the expected king. A trace of this view is found in KEPLER'S writings in which he expresses the opinion that the conjunctions of the great planets coincides with the approach of climaxes in human affairs, and names as examples the birth of ENOCH and the Deluge, the births of MOSES and CYRUS, and the births of JESUS CHRIST, CHARLEMAGNE and LUTHER.

The correctness of the views held by ENCKE and others in regard to the time and circumstances of these conjunctions, is, so far as we know, one unquestioned by modern astronomers, including so high an authority as the late Astronomer Royal of England. Although these facts be true, does it follow that these conjunctions could have been called properly a star, which is plainly the meaning of Matthew's account? Astronomers think not, and have generally given up this hypothesis first advanced by one of their own number.

Respecting the theory that the star seen was a comet it need only be said, that no evidence has been found to support such a claim.

In the matter of new or temporary stars the records contain something of interest. By a new or temporary star is meant one that suddenly flashes out where none has been noticed be-

fore, and as suddenly dwindles away to a telescopic star, or disappears altogether. Among others that have been spoken of in connection with this theme we will notice only two: TYCHO BRAHE'S star and the star of *Coma Berenices.*

There is probably not another new or known variable star that has so wonderful a record as that which bears the name of TYCHO BRAHE. His own words best describe impressions at first sight, as follows: "Raising my eyes as usual, during one of my walks, to the well known vault of heaven, I observed with indescribable astonishment, near the zenith in *Cassiopeia*, a radiant fixed star of a magnitude never before seen. In my amazement I doubted the evidence of my senses. However, to convince myself that it was no illusion, and to have the testimony of others, I summoned my assistants from the laboratory and inquired of them, and of all the country people that passed by, if they also observed the star that had thus suddenly burst forth." Going on with the description TYCHO BRAHE speaks of its brightness as greater than that of *Sirius*, *Vega* or *Jupiter*. For splendor it was only comparable to *Venus* when nearest to the *Earth*, and was seen by some at noonday. After a few weeks it began to decline and in sixteen months became invisible to the naked eye (the telescope being invented thirty-seven years later).

In waning the star passed through changes of color, from white to yellow and red and then to white again. These phenomena interested TYCHO BRAHE so much that he wrote a large book describing the appearance of the star as seen by himself and others, and gave theories to account for those wonderful changes. It has since been thought that this star appeared also in 945 and 1264. If it be a variable star with period of about 314 years, it would make its time of appearance about the beginning of Christian era and also its re-appearance probable, in some slight degree, in 1886. In consequence of this latter supposition astronomers in Europe have been watching its place in *Cassiopeia*, which is now closely marked by a faint

star, with special attention, for the last ten years.

In TYCHO BRAHE's time it was claimed by one CARDANUS that this was the star which the Magi saw.

The star of *Coma Berenices* is spoken of as appearing immediately preceeding the birth of CHRIST and was so bright as to be visible by day. HIPPARCHUS and PTOLEMY speak of this star, and IGNATIUS says that it "sparkled in brilliancy above all stars." Chinese records also mention a new, bright star at this time; but none of these statements have we been able to verify from the best authority. In Dr. SEISS's view of the divine origin of the constellations, the theory of this last named temporary star is certainly very suggestive and possibly not too fanciful to be true. So uncertain is all our knowledge of the Star of Bethlehem from records within our reach at the present time.—*Chicago Advance.*

RECENTLY DISCOVERED ASTEROIDS.

PROFESSOR DANIEL KIRKWOOD.

The discoveries in the zone of asteroids since January 1, 1884, are as follows:

Numbers 236 and 237, *Honoria* and *Cœlestina*, were discovered by Dr. PALISA of Vienna; the former on the 26th of April and the latter on the 27th of June. They are of the 12th or 13th magnitude. No 238, *Hypatia* was discovered on July 1 by Dr. KNORRE, of Berlin—the same astronomer who had some years since detected the minor planets, *Coronis* and *Oenone*. *Adrastea*, the next in order of discovery was discovered on the 18th of August by Herr PALISA. It is of the thirteenth magnitude. This discovery placed Dr. PALISA foremost in the list of planet finders; being the forty-third which he had first detected. No. 240, *Vanadis*, of the twelfth magnitude, was found on August 27th, by M. BORELLY, at Marseilles The next, *Germania*, was discovered on September 12th, by Dr. LUTHER, at

Dusseldorf. It is of the eleventh magnitude. Nos. 242, *Kriemhild*, 243, *Ida*, and 244, were discovered by PALISA, at Vienna, on September 22nd, September 29th and October 14th, respectively. The elements of No. 241, *Germania*, very closely resemble those of No. 133, *Cyrene*. No. 244 has not yet been named. Dr. PALISA, desirous of raising funds to defray the expense of his expedition to observe the total eclipse of the sun in August, 1886, will sell the right of naming this asteroid for two hundred and fifty dollars.

The first minor planet of 1885, and the 245th of the cluster was detected by M. BORELLY on the 6th of March. It is of the eleventh magnitude.

Hersilia, the 206th asteroid was discovered by Dr. C. H. F. PETERS, Oct. 13th, 1879. The observations then obtained were not sufficient for the determination of its orbit, and the planet was not re-observed till December 14th, 1884. Its elements are given below with those of the planets recently discovered.

ELEMENTS OF RECENT ASTEROIDS.

	Asteroid	Mean Dist.	Period	Eccen	Long. of Perihelion	Long. of Asc. Node	Incli-nation
			d.		° ′ ″	° ′ ″	°
206	*Hersilia*	2.752	1667.7	0.045	95 23 14	145 1 55	3 46
236	*Honoria*	2.933	1835	0.219	328 56	185 34	7 9
237	*Cœlestina*	2.807	1719	0.102	295 46	84 38	9 39
238	*Hypatia*	2.911	1814.2	0.090	29 12	184 29	12 25
239	*Adrastea*	2.978	1873	0.228	26 1	181 34	6 14
240	*Vanadis*	2.654	1579.2	0.194	52 52	115 20	2 7
241	*Germania*	3.047	1943.3	0.089	344 50	272 7	5 33
242	*Kriemhild*	2.972	1871.3	0.257	134 31	208 16	12 53
243	*Ida*	3.001	1878.4	0.303	142 25	329 45	1 15
244		2.174	1170.7	0.136	13 57	208 33	2 49
245							
246							

REMARKS.

1. No. 244 is on the inner edge of the zone; its mean distance being the least with the exception of *Medusa*.

2. The orbits of *Hersilia*, *Hypatia* and *Germania* are nearly circular, and those of *Ida* and *Vanadis* are nearly coincident with the plane of the equator.

3. The number of asteroids discovered in consecutive periods of five years each is seen at one view in the following table:

Discovered previous to 1845	4	asteroids
From 1845 to 1849, inclusive	6	"
1850 to 1854, "	23	"
1855 to 1859, "	24	"
1860 to 1864, "	25	"
1865 to 1869, "	27	"
1870 to 1874, "	32	"
1875 to 1879, "	70	"
1880 to 1884, "	33	"
In 1885	1	
Whole number	245	

The maximum was reached in the five years from 1875 to 1879; a maximum which, when we consider the increasing difficulty of discovery, seems hardly likely to be surpassed.

THE SCHOOL OF PRACTICAL ASTRONOMY AT WILLET'S POINT — NEW YORK HARBOR.

A very interesting report is published by General H. W. Abbot, of the Corps of Engineers, U. S. Army, on the astronomical work which has been done during 1884 at the engineer post of Willet's Point, New York Harbor. It is to this school of application that young officers of engineers are sent to learn the practical application of their studies at West Point. They are taught the practice of military surveying, mining, torpedo service, etc., and also the application of astronomy to military and boundary surveys. Each year a general order is issued, giving the results of the past year's work in practical astronomy. The order for 1884 may be summarized as follows:

Each officer makes a long series of determinations of the local time, with various instruments, and in various ways. With the portable transit, the time of transit is at first recorded by an assistant, at the word given by the observer; next, the observer records his own time by the relay beat of a chronometer

every one second; next by the chronographic method, and lastly by the beat of the chronometer itself (every 0.5 second). Beginners use these methods in succession in the order named.

Personal equation is studied by means of Eastman's machine (see Wash. Ast. Obs., 1875).

The time determinations with the transit are given for each day of observation, with the probable errors.

Time determinations by sextant observations are also given, and by means of the (known) correction of the standard chronometer the error of each observation and observer is determined.

We quote below the errors of the sextant clock corrections so determined. (Usually ten altitudes of an east star and ten of a west were employed:) 3*s*.0; 3.8; 2.0; 1.2; 6.5; 1.8; 1.9; 0.9; 0.7; 0.1; 0.9; 1.0.

Observations for latitude were made by the sextant and by zenith telescopes. With the sextant the errors in seconds of arc were as follows: 1=101 feet. 1″.0; 4″.3; 2″.2; 7″.4; 1″.7 1.″5; 10″.4.

A table of the separate latitudes obtained by each observer, with each instrument from each pair of stars(Safford's Catalogue) is given in detail, and compared with the results of past years.

The mean of all the observations for latitude made in 1884 is as follows, all pairs and observations having equal weight. Zenith Telescope by Wurdemann (190 observations on 43 pairs) gives 40° 47′ 20″.57. Zenith Telescope by Lingke (333 observations on 54 pairs) gives 40° 47′ 20″.92. Grand mean for Observations of 1884, giving observations and instruments equal weight is 40° 47′ 20″.75. The results of previous years are added for comparison. 1=101 feet.

Transferred from old observatory				40° 47′ 21″.70 ± 0.575
In 1880 (326 observations	from	84 pairs)		21.59 ± 0.082
1881 (591	"	" 104	")	21.47
1882 (235	"	" 60	")	21.37
1883 (497	"	" 118	")	21.15
1884 (523	"	" 89	")	20.75

"The grand mean of 2,172 observations made at the new observatory during the past five years is 40° 47′ 21″.23; but it will be noticed that there has been a steady reduction in the yearly means during this entire period, and that the less exact determination at the old observatory indicates a change in the same direction."

Although the nature of the observations and the small absolute value of the quantity in question renders it quite possible to attribute this solely to errors of observation, the fact is nevertheless an extremely interesting one in its relation to the variability of terrestrial latitudes.

The observations of each observer for each pair of stars are given by General ABBOT, and an analysis of the results of the separate years, arranging the results by pairs, by instruments and by observers would probably show whether the very remarkable diminution indicated in the table corresponds to a real phonomenon or whether it is due to the chapter of accidents. The separate observations are not remarkably precise, as they are made by students for practice, but it would seem that their great number would compensate for this in its effect on the general mean.

Longitude was determined by lunar culminations and the errors of each separate result compared with the known (telegraphic) longitude were: 7*s*.5; 36.6; 2.2; 15.1; 3.8; 10.4; 14.6; 5.5.

Longitudes by lunar distances were also determined with errors as below: 16*s*.5; 12.9; 7.3; 6.7; 46.4; 39.7; 23.9; 11.7.

Auroral displays are regularly noted by the sentinels, and an interesting table of the results since 1870 is given.

What has been given as an abstract of one year's work in only one department of this school of application for young engineer officers is sufficient to show that we have at present no better school of practical astronomy in America.

EDWARD S. HOLDEN.

THE RED SPOT ON JUPITER.

PROFESSOR C. A. YOUNG.

The great red spot still remains visible; in position, size and form it has hardly changed at all from what it was four years ago, but it has become so faint as to be seen only with difficulty even in a large telescope; and recently a white cloud has appeared upon it which threatens in a short time to hide it completely. As seen at the Halsted observatory last week (March 23rd, 25th and 26th) with the 23-inch equatorial, the white cloud was almost exactly concentric with the red spot, and of the same form, leaving visible only a faint, narrow, reddish, oval ring about $1\frac{1}{2}''$ or $2''$ wide, to mark the outline of what a few years ago was by far the most conspicuous feature of the planet's surface. The outline of the white cloud is for the most part very regular, and the red ring is of almost uniform width; but at the western end of the spot there is a little projection of the cloud, which almost cuts across the ring; and perhaps there may be a very narrow canal connecting the cloud with the white belt outside, which forms the background for the red spot The cloud, in tint and brightness, so closely resembles the belt, that if it were not for the reddish rim around it, it would be quite invisible. On the 26th I was able to make out the red spot and its overlying cloud with the $9\frac{1}{2}$-inch equatorial of the student's observatory, but do not think I should have detected them if I had not seen them before with the larger instrument.

There are at present a number of peculiar and interesting markings upon the planet, especially on the equatorial belt; one dark spot in particular on the S. equatorial belt just under the red spot, appeared almost as sharp and definite as a satellite shadow in the smaller telescope.

On the 25th, about an hour and a half before the red spot reached the central meridian, there were visible on the south *polar* belt of the planet (Lat. 50° to 65°) nine brilliant white spots, each about as large, and several of them as round and as

well defined, as the discs of satellites. These bright spots were seen again on April 1st, having preserved their configuration sensibly unchanged during the intervening week. The seeing on this occasion was not good enough to permit an entirely satisfactory observation of the central meridian passage, and the rotation time, deduced by a comparison of the observations of March 23rd and April 1st, may therefore easily be erroneous by 3 or 4 tenths of a minute. It comes out $9^h\ 55^m\ 16^s$, which is 22 seconds *less* than that indicated by the red spot. The difference may or may not be significant. The *equatorial* white spots, it will be remembered, rotate in $9^h\ 50^m\ 12^s$.

EDITORIAL NOTES.

The meeting for 1885 of the American Association for the Advancement of Science will be held at Ann Arbor, Michigan, commencing Wednesday, August 26th, and continuing probably one week. Though Ann Arbor is not a large place, the fact that it accommodates nearly two thousand persons belonging to the University of Michigan during the greater part of the year, is proof that the place can afford ample facilities for the large summer meeting of the American Association.

OBSERVATIONS OF THE SOLAR ECLIPSE OF MARCH 16TH AT PRINCETON.

The eclipse was observed here at two stations; at the Halsted Observatory, and at the Observatory of Instruction, the former being about 2" west and 2" south of the meridian circle in the latter. The observations at the Halsted Observatory were made by myself with a grating spectroscope upon the 23-inch equatorial. I recorded the first contact at $23^h\ 50^m\ 33.7^s$, sidereal time, using the clock beats of the standard clock, transmitted telegraphically from the other observatory. This corresponds to $12^h\ 11^m\ 22.8^s$ by Eastern standard time. The observation was made by noting the occultation of the chromosphere by the limb of the moon, the slightly open slit being set tangential at the predicted point of contact. The seeing was bad, and the chromosphere was rather unusually thin at the point observed so that the moon's limb did not become visible more than two seconds before the contact, but notwithstanding this, the observation was easy and satisfactory. I do not think the error can exceed half a second; *late*, if anything.

At the working observatory Mr. MCNEILL observed the contact in the usual manner, using the 9½-inch equatorial (with full aperture), a polarizing helioscope and negative eyepiece magnifying 220 times. He re-

corded contact on the chronograph at $23^h\ 50^m\ 34.2^s$ sidereal, or $12^h\ 11^m\ 13.3^s$ Eastern standard time: he notes the observation as satisfactory. The half-second of difference between his time and mine is more than accounted for by the difference in the position of the two stations, which would make the eclipse begin about one second earlier at the Halsted Observatory than at the other. Several of our students also observed the image of the sun made by a 9 inch reflector upon a suitable screen, but in all cases their observations were obviously late, from a few seconds to more than a minute. The last contact was lost at both stations by clouds.

During the eclipse, as long as the sky was reasonably clear, I studied carefully the B line and other atmospheric lines, putting the slit into all possible positions with reference to the *Moon's* limb, and using a great variety of dispersive and magnifying powers. My results did not corroborate at all those reported by some of the French observers in 1882: I could not find the slightest trace of any lunar atmosphere.

At the other observatory Mr. McNEILL made similar observations, and with similar results, except that he records an impression that at one or two places on the *Moon's* limb there might have been a little broadening and fraying out of some of the components of the B group — nothing certain. But the state of the sky was such that our spectroscopic results cannot claim any great weight. C. A. YOUNG.

PRINCETON, N. J., March 1885.

Under date of April 1, Prof. YOUNG further says: "I find that Mr. McNEILL would put his impression of the thickening of the B lines at the *Moon's* limb a little more strongly than I gave it. He is not *confident* about it, but his *suspicion* was a very strong one, he says."

Notes on the Occultation of the Sun, as seen at Hillsdale College, March 16, 1885. *By* PROFESSOR A. E. HAYNES.

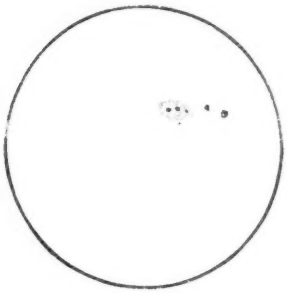
The sky at this place was cloudless and the atmosphere was very clear and steady. The view as a consequence was surpassingly fine.

Three interesting points were noted during the time I was using the telescope. First, that the *Moon's* limb or edge where the sunlight passed it, seemed to be *slightly* serrated, or notched, thus showing that the *Moon's* surface is not regular or smooth. Second, that the light of the sun which passed the *Moon's* limb, did not appear to lose any of its intensity; in other words, the part of the sun visible appeared uniformly and equally bright, except where sun spots were seen, up to the very edge of the *Moon's* outline, as it appeared projected upon the *Sun's* face; thus suggesting that the moon has no atmosphere, or perhaps more cor-

rectly that it has no atmosphere which obstructs the light. Third, that the central part or umbra as it is called, of a large sun spot appeared nearly as dark as the face of the *Moon*. This was the most interesting observation of the three.

In the early morning I had been watching a large group of sun spots, and two other spots widely separated from this group, forming an irregular line of these spots, apparently extending across nearly a quarter of the *Sun's* disc.

One spot in this group, the largest, and lower one as it appeared in the inverting telescope, was of no little size and appeared very dark.



Sun's Appearance 9h. 0m. A. M.

Sun's Appearance 12h. 49m. P. M.

Later in the day, after the time of the eclipse had partially passed, this group of spots was hidden from view by the *Moon's* passing before it and my line of vision. After a short time, however, by patiently watching, I had the rare pleasure, as the *Moon* changed her position, of seeing this large spot lying apparently close to the *Moon's* limb, thus furnishing an admirable opportunity of comparing the relative brightness of her sable features and that of the spot on the radiant face of the *Sun*.

The last contact took place at Hillsdale (Long. 84° 38½′, Lat. 41° 55¼′) at 1:39 p. m., Central Standard or 90th meridian time.

Above are given copies of diagrams made at time of occultation, March 16, 1885.

The address of Professor HALL, the leader of this number, was given at the opening of the Leander McCormick Observatory of the University of Virginia, one of the largest and most important gatherings in the interest of astronomy held in the United States in recent times. This great observatory, with a refracting telescope equal in size to the Washington instrument, has been erected under the supervision of Professor ORMOND STONE, Director during the last two years. Some of the noted gentlemen present at the opening exercises were as follows:

Prof. Asaph Hall, of the United States Naval Observatory; Prof. Simon Newcomb, of the Johns Hopkins University; Prof. G. W. Hill; Prof. H. A. Newton, of Yale College; Dr. Elkin, of the Yale Observatory; W. Roane Ruffin, rector of the University of Virginia; Hon. B. Johnson Barbour, R. G. H. Keane, formerly rectors of the University of Virginia; Charles M. Fry, president of the Bank of New York, George W. Byrd, New York, and Charles M. Blackford, president of the Society of Alumni.

Letters were received from Gov. Stevenson, of Kentucky; Hon. A. H. H. Stuart, Hon. Willis P. Bocock, of Alabama; W. W. Corcoran, of Washington; Prof. Young, of Princeton Observatory; Prof. Hilgard, of United States coast survey, and Prof. Holden, of Wisconsin University Observatory, and other friends.

Observations of the First Contact of the Partial Solar Eclipse of March 15–16, 1885, Made at the U. S. Naval Observatory, Washington.

(Communicated by Rear Admiral S. R. Franklin, U. S. Navy, Superintendent.)

Washington Mean Time.	Observer.	Remarks.
March 15.		
h. *m.* *s.*		
23 57 6.9	H.	Observation fair, perhaps one or two seconds late. The instrument was the 26-inch equatorial, with aperture reduced to 4 inches and power 383.
23 57 4.7	F.	Observed with 9.6-inch equatorial, with aperture reduced te 4 inches and power 90. Observation satisfactory.
23 57 7.	P.	Aperture 5 inches, magnifying power about 90. Do not think I could have observed it one second earlier with the state of the atmosphere as it was.

No observations of the last contact could be made on account of clouds.

The observers are Prof. A. HALL, Prof. E. FRISBY, and Assistant Astronomer H. M. PAUL.

The difference of right ascension of the second limbs of the *Moon* and *Sun* was observed by Lieut C. G. BOWMAN, on 11 wires of the East Transit Instrument, and by Assistant Astronomer W. C. WINLOCK, on 9 wires of the Transit Circle. The *Moon's* limb was faint at times, owing to flying clouds. The *Sun's* limb was but moderately steady.

RESULTS.

B., Diff. $1m.\ 56.49s. \pm .028s.$
W., $1m.\ 56.25s. \pm .081s.$

Ninety-nine photographs of the various stages of the eclipse were taken with the photo-heliographic apparatus of the Transit of Venus Commission, by a party consisting of Commander BROWN, Ensigns TAYLOR and WINTERHALTER, and Mr. W. F. GARDNER, the instrument maker of the Observatory. The exposures were made by Ensign WINTERHALTER.

The MESSENGER is favored by the following astronomical notes from E. E. BARNARD, Vanderbilt University, Nashville, Tenn.:

Jupiter's Satellite IV. On the night of February 27th I witnessed a black transit of *Jupiter's* fourth satellite; at the same time the shadow was in transit following it. The satellite was as black as its shadow, and only about one-half as large. The satellite retained its dark cast up to the moment of the beginning of its egress. After emergence it was inferior to the other moons in luster, when a high magnifying power (200) was used; but when a power of 60 diameters was applied, it appeared with the same as I. and II., and was fully as bright as the brightest part of the planet. The only thing remarkable about IV. after it left the planet was, that it seemed to fade more when high powers were applied than the other moons, its light appearing more feeble with the increase of power than that of either I. or II. The III. satellite was large and bright.

"*Gegenschine.*" March 19th at midnight; pretty large, hazy, "Gegenschine" visible 3° northwest of *Gamma Virginis.*

Aurora Borealis. An Aurora was visible on the night of March 15th, from 6*h*. 50*m*. to about 7*h*. 30*m*. At 6*h*. 50*m*. (90th meridian time) streamers were ascending fifteen degrees to east of north; these died out in a few minutes, leaving a large pinkish cloud at an altitude of some ten degrees which remained visible some time. After the cessation of the streamers to the east of north, similar streamers appeared at almost the same distance west of north, and remained visible for a few minutes; presently these died out, leaving a pinkish mass of smoke similar to that observed in the north-east, and after a time vanishing in about the same way. During the entire night there was more or less auroral light in the north horizon.

Nebulæ, New and Old.—In the SIDEREAL MESSENGER, No. 32, I gave approximate places of two new nebulæ. The following are more accurate places of the objects: First nebula,

	R. A.	3*h*	14*m*	0*s*.	1885.0
	Decl.	—19°	30′	43″	

Second nebula.

	R. A.	3*h*	14*m*	54*s*.6	1885.0
	Decl.	—26°	28′	43″	

General Catalogue, No. 689.—This nebula, as noticed by me in MESSEN-

GER, No. 32, is erroneously located in Herschel's General Catalogue. Taking the mean of several approximate positions of this object, I get for its place,

R. A.	3^h	14^m	30^s	1885.0
Decl.	$-19°$	$50'.8$		

The place given in G. C. for same epoch is

R. A.	3^h	14^m	30^s
Decl.	$-20°$	$49'$	$37''$

Hence the position in G. C. is too far south by about one degree.

New Nebula.—On February 11th, I found with five inch refractor, a faint nebula in

R. A.	9^h	12^m	40^s	1885.0
Decl.	$-21°$	$52'$	$0''$	

This nebula lies close between an 8.8 magnitude and a 9 magnitude star with a 10 magnitude star involved following.

Note on G. C. 1409. Herschel gives the place and description of this object for epoch 1860.0 thus: "AR=6^h 19^m $57^s.6$; N. P. D.=99°34' 30".9. Cl; P; lCM : st, 12..15." Almost in this spot on March 9th, I found a very small and very difficult nebula close north of a 10 magnitude star, between it and a 11 magnitude star. I tried it with six inch equatorial, and could only make out a small indefinite nebulosity, quite hard to see on account of the two stars. I find nothing near this spot that will answer the description in G. C. There is something wrong here.

E. E. BARNARD.

A LEGAL STANDARD OF TIME FOR WISCONSIN.

On the recommendation of the R. R. Commissioner of the State, the following bill has been passed by the Legislature of Wisconsin:

"The legal standard of time within the State of Wisconsin shall be the mean solar time of the 90th meridian west from Greenwich, now commonly known as 'Central Time.'"

Although there are sound reasons which could have been brought forward against the new railway time (which so far as I know were not brought forward) *before* its universal adoption, there seems to be no question but that the practical standard of time in Wisconsin is Central Time, and that it will remain so. As there are many advantages in having the practical standard of time also a legal standard, this bill has received the support of the Washburn Observatory.

E. S. HOLDEN.

Observations of the Solar Eclipse of March 16, 1885, at the John P. Williston Observatory, South Hadley, Mass., by Misses E. M. BARDWELL *and* I. G. MACK, *Teachers of Mathematics and Astronomy in Mt. Holyoke Seminary.*

(Communicated by Prof. C. A. Young.)

The geographical position of the Observatory is, Lat. 42° 15′ 18.2″, Lon. 18*m*. 05.0*s*. E. from Washington. The observations were made with the 8-inch equatorial (full aperture), and an ordinary diagonal solar eyepiece; power not rated, but probably about 100. The clock error was determined by Transit-instrument observations on the 13th, 14th and 17th. Flying clouds and haze were more or less troublesome during the whole time of the eclipse, but satisfactory observations of both the contacts were obtained by Miss BARDWELL.

The first contact was noted at 0*h*. 26*m*. 31.0*s*. local mean time; or 0*h*. 16*m*. 38.2*s*. standard time. The second at 3*h*. 03*m*. 59.7*s*. local mean time; or 2*h*. 54*m*. 06.9*s*. standard time.

During the eclipse the spectrum of the *Moon's* limb was carefully examined with a spectroscope having a grating of 8640 lines to the inch. Nothing decisive was noted, though both observers at times thought that certain lines between 74 and 76 of KIRCHOFF's scale were perhaps a little thickened and strengthened just at the edge of the *Moon*. Another set of lines between *b* and F seemed also to behave in the same way; but in neither case did the impression amount to anything like a certainty.

Subscriptions and orders received for the MESSENGER not previously acknowledged are as follows:

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BOOK NOTICES.

Elements of Analytical Geometry, by SIMON NEWCOMB, Professor of Mathematics in Johns Hopkins University. MESSRS. HENRY HOLT & COMPANY, Publishers, New York, 1885, pp. 356, price, $1.50

This book begins with the fundamental concepts of algebra and geometry which are stated and applied, in the first twelve pages, in a way to test the student's ability to undertake analytical geometry profitably.

The body of the text corresponds closely to the usual college course in plane analytical geometry, with some noticeable additions, Under the Straight Line is found a section devoted to the use of abreviated notation, which is both easy and elegant. The subject of Synthetic Geometry of the Circle is added in its proper place, besides other topics of similar interest. Part II is devoted to Geometry of three dimensions, and Part III gives a full introduction to Modern Geometry. This book is clear and concise in statement of principles, and in kind and variety of exercises, is unusually and happily strong. However, in its applications we notice with regret that its distinguished author has omitted altogether the use of the infinitesimal analysis. When a student knows the relations between equations and loci, and can pass from one to the other with facility, the elements of the Calculus render invaluable service in carrying form and analytical investigation, and in deducing in another way many of the most common laws pertaining to plane loci. The writer is convinced, from experience as a teacher, that the larger use of the infinitesimal analysis gives more direct and satisfactory results in developing and applying the principles of the higher mathematics than are ob-

tained by methods more commonly used. And with reason, because the infinitesimal analysis is not at all inherently difficult, and if this be so, why should not its use be early introduced in college study and students be taught to think in, and work with one of the most common, refined and powerful instruments known to modern mathematical research.

Le Contes' Compend of Geology. D. APPLETON & CO., PUBLISHERS.

A copy of this work having come into my possession through the courtesy of the Chicago Agent of the publishers has been reviewed with pleasure.

Not long since at a meeting of the American Association for the Advancement of Science some very sharp criticisms were passed upon American Scientific works, the implication being that we had no books that were up with the times.

Such books as this of Professor LE CONTES', are the best answers to such criticisms. In the matter of text books for general students we believe that America is not only more bountifully, but better provided than the rest of the world.

There have been admirable books upon geology before this one, but to the instructor, looking for a work which should contain the material for instruction in a college class, which could give but a single term to geology, and yet desired a full view of the subject, there were moments of despair.

The great difficulty has been that either the books were overloaded with detail, or else presented the subject in such general outline as to be unsatisfactory. It would be extravagant to say that Professor LE CONTE has produced a perfect book. It is however fair to say that for such class work as indicated it is the only thing we have which meets the requirements.

The completeness with which geological agencies are treated is especially noteworthy. Nothing so furnishes the student to grapple with the detail of Historical Geology as a thorough presentation of the agencies which are and have been concerned.

The manner of presentation has in it that elusive quality which we all call style. The book is good reading aside from its accuracy and scientific value. The illustrations are abundant and typical and for the most part free from that crowding of many figures upon one plate, which is so confusing to the student.

On the whole instructors in geology are to be congratulated upon having such a compend to place in the hands of their classes.

L. W. C. JR.

Carleton College, May, 1885.

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CALENDAR.

Spring Term begins Wednesday, April 1, and ends June 18, 1885.
Examinations to enter College, June 12 and 13. and Sept. 8, 1885.
Term Examinations, June 16 and 17, 1885.
Anniversary Exercises, June 15–18, 1885.
Exihbition at Art Room of work of Pupils in Drawing and Painting, June 15–18, 1885.
Wednesday, September 9, 1885, Fall Term begins.
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